Measurement of *In Situ* Acoustic Properties for the ONR Geoclutter Program

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LONG-TERM GOALS

Our long-term goal is to provide data critical to the assessment of geologic clutter/reverberation issues in a seismically and geologically well-characterized shallow-water environment. This will be done within a context of a broad set of experiments aimed at: 1- understanding, characterizing, and predicting the lateral and vertical, naturally-occurring heterogeneities that may produce discrete acoustic returns at low grazing angles (i.e., "geologic clutter") in a mid-outer shelf test site off the U.S. (New Jersey), and then 2- conducting precise acoustic reverberation experiments at this site in order to understand, characterize, and potentially mitigate the geologic clutter, so that the false alarms, or detects, of tactical sonar systems encountered in this marine geologic environment around the world can be characterized properly.

SCIENTIFIC OBJECTIVES

The specific objectives of this program are to develop a means of rapidly measuring *in situ* sound speed and potentially attenuation in the near surface sediments of the proposed study area. These measurements will be combined with georeferenced core samples to provide a full suite of acoustic measurements that will characterize the near-surface sediments of the Geoclutter area.

APPROACH

We propose to develop a relatively compact, ship-deployed package that will be lowered by conducting wire to the seafloor and make *in situ* measurements of sound speed (in several directions) as well as attenuation. The device will be modeled after the well-proven Dalhousie Sound Velocimeter that has been used both in the laboratory and for *in situ* measurements from submersibles (Mayer, et al., 1987; Courtney and Mayer, 1993a)

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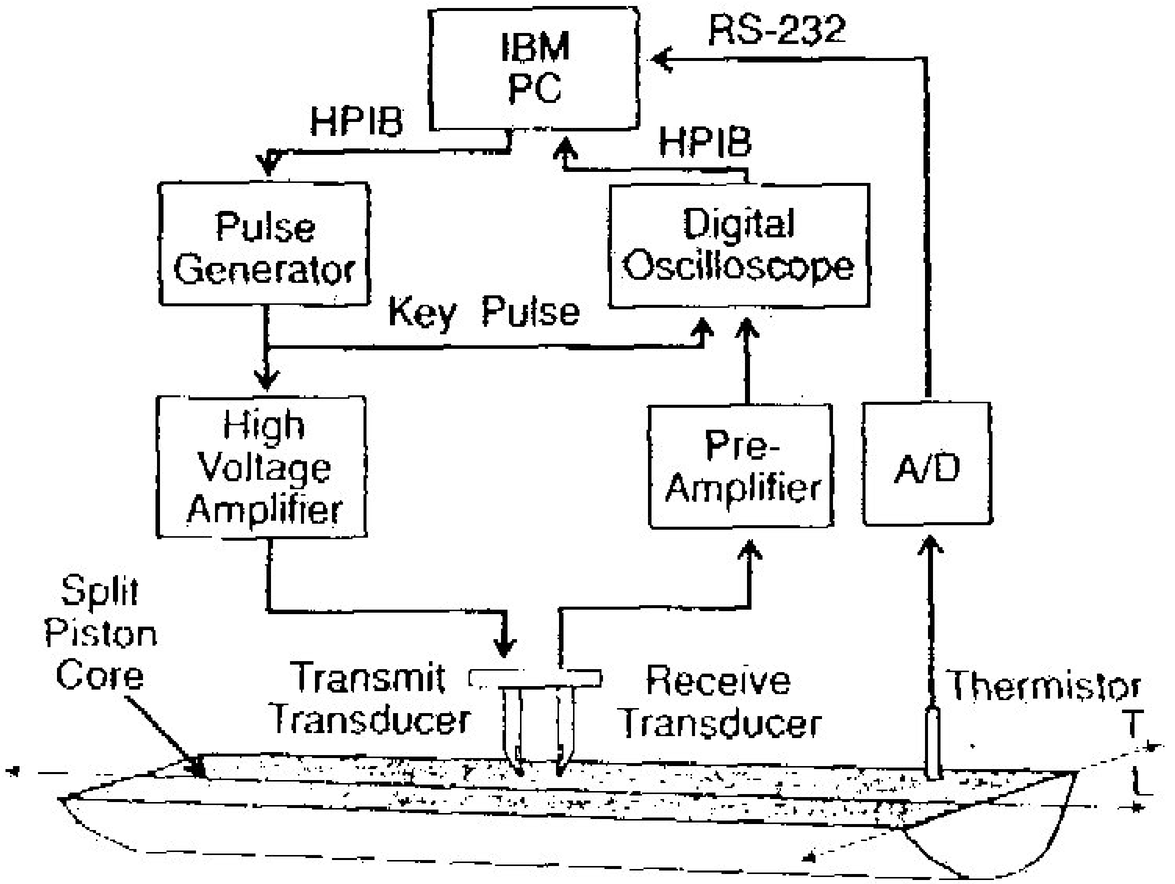

R. C. Courtney and L. Mayer: Fine-grained sediments 3195

Experimental setup of the Dalhousie Sound Velocimeter (DSV). An IBM PC acts as a central controller over an HPIB parallel interface. Software control triggers a pulse generator, sending a high-voltage pulse to the transmit side of the transducer pair. Waveforms received on the other transducer are amplified and then digitized in a digital oscilloscope. Digital waveforms are stored on disk on the PC. Temperatures are logged via serial RS-232 line.

This laboratory sediment velocimeter measures the time-of-flight of 100 – 1000 kHz compressional sound waves traversing the same volume of sediment between several sets of transducers (typically mounted orthogonally to explore aniostropy). A commercial version of this system was developed by IKB Technologies and has been used for many years by the Ocean Drilling Program and several laboratories around the world. Post processing algorithms have been developed which permit the calculation of acoustic attenuation using a filter-correlation method which has been demonstrated to be robust even for the short time series involved in a system like this (Courtney and Mayer, 1993b). This technique has the added benefit of providing more precise sound speed measurements (than those made by determining first arrivals) and has been shown to be able to measure velocity dispersion in fine-grained sediments (Mayer and Courtney, 1993b). Modified versions of this system have been

used to make *in situ* measurements of the acoustic properties of Arctic sediments from the Canadian Navy DSL submersible.

For the Geoclutter work we propose to design a relatively small footprint package (less than 1 m across) that will contain a 4-pronged fork arrangement with transducers separated by paths of 15 to 25 cm. The transducers would operate at approximately 100 kHz to closely match the 95 kHz of the multbeam sonar backscatter measurements and penetrate the upper 10 – 15 cm of the seafloor – again to match the penetration of the multibeam sonar signals. The transducers and base-plate would be mounted on guides beneath a tripod (or other shaped) stand with a single cable lowering and lifting arrangement. The cable would carry power and control signals down to the velocimeter and the acoustic returns and telemetry back to the surface. We also hope to incorporate a camera on the package to better understand the nature of the bottom before a measurement is made as well as to document the penetration of the velocimeter probes.

Preliminary measurements of sound speed can be made in real-time on board the research vessel using a dedicated PC and the waveforms would be captured for later analysis of attenuation and dispersion. There will be up to 6 different acoustic paths and measurements can be made in the water column as well as the seafloor (to understand the *in situ* bottom water/seafloor sound speed ratio). In addition to sound speed we will also provide measurements of pressure (depth), water temperature, range to bottom contact, and have two spare channels (one perhaps for orientation and one for resistivity?). The system will be self-calibrating as transducer offsets will be fixed and the transducer offsets can be determined while the velocimeter is being lowered in the water column. Upon arrival at the bottom sound speed measurements will be made over the selected paths and the unit can then be lifted and relowered as necessary for repeated measurements. The system will be designed to work with the winches and cables available on the *R/V Cape Henlopen* and to operate to depths of up to 250 m.

Using this system we hope to be able to get a reasonable idea of the lateral distribution of sound speed and attenuation variations within the Geoclutter area. These measurements will be compared directly to backscatter values from the multibeam system and to the predictions of impedance and attenuation made from the Chirp Sonar by Schock.

Sediment properties at depth will be established both directly, through long coring and borehole logging, and indirectly, through analysis of the multifrequency CHIRP data. We anticipate that long coring will take place as part of the last phase of the ONR STRATAFORM program (Austin is the lead PI for this project and Olson a co-PI).

The work described above will play a key part in the overall development of robust seafloor characterization approaches, particularly through helping to better constrain the relationship of high-frequency backscatter to seafloor properties. It will also provide critical information on the relationship of *in situ* properties to those made in the laboratory as well as those extracted remotely from the inversion of seismic (Chirp Sonar) data.

WORK COMPLETED

A preliminary design study has been completed for the velocimeter electronics and several designs for the deployment system are under review.

RESULTS

None to date.

IMPACT/APPLICATIONS

The ability to make rapid measurements of in situ sound speed and attenuation should be an asset to many trying to understand acoustic interaction with the seabed.

TRANSITIONS

None yet.

RELATED PROJECTS

This is a cooperative effort between UTIG (Goff and Austin), FAU (Schock) and the Center for Coastal and Ocean Mapping (Mayer).

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